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THE SKELETON OF TRIMERORHACHIS

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A year ago, in a paper on the structure and habits of *Trimerorhachis*, I said, that "it will only be by the fortunate discovery of a connected skeleton that the tail, ribs, and feet will be made known."[1] Such a specimen has been discovered and skilfully worked out by Mr. Paul Miller, a photograph of which, as prepared, is shown in Fig. 1. The specimen came from the paleontologically famous Craddock Ranch, near the town of Seymour, Texas, from the same horizon as that of the skeleton of *Seymouria*, described by me a few years ago, and within a stone's throw of its locality. Its horizon seems to be nearly the same as that of the Craddock bone-bed, from which so many remarkable specimens have come. When found, the specimen was inclosed in a large, irregular nodule of bright red claystone; nothing was visible of it except the extreme tip of the nose and the base of the tail, as shown by a fracture. The under side of the nodule was smoothly convex both longitudinally and transversely; its upper side was irregular and gnarly. With this specimen, and in immediate relation with it as it lay upon the surface, were found a number of pieces, which, when fitted together, formed a block about one foot in length, which seemed to be a continuation of the tail end of the larger block. When fully prepared, however, the smaller block proved to belong to a second specimen of *Trimerorhachis*, including about twenty chiefly precaudal vertebrae, with their ribs and an imperfect femur.

The larger specimen, that figured herewith, is a nearly complete skeleton as far back as the sixth or seventh caudal vertebra. The bones, as usual in such nodules, are white and rather soft, rendering their preparation in the hard matrix difficult. It has been worked out so far as was possible without going below the surface of the bones.

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[1] Cope, *Proc. Amer. Phil. Soc.*, XVII (1878), 524; XIX (1880), 54; *Amer. Naturalist*, XVIII (1884), 32; Case, *Revision of Amphibia and Pisces of North America* (1911), 39, 106; Huene, *Bull. Amer. Mus. Nat. Hist.*, XXXII (1913), 372; Broom, *Anatom. Anzeiger*, XLV (1913), 73; *Bulletin Amer. Museum*, XLV (1913); Williston, *Journal of Geology*, XXI (1913), 625; XXII (1914), 160; XXIII (1915), 246.

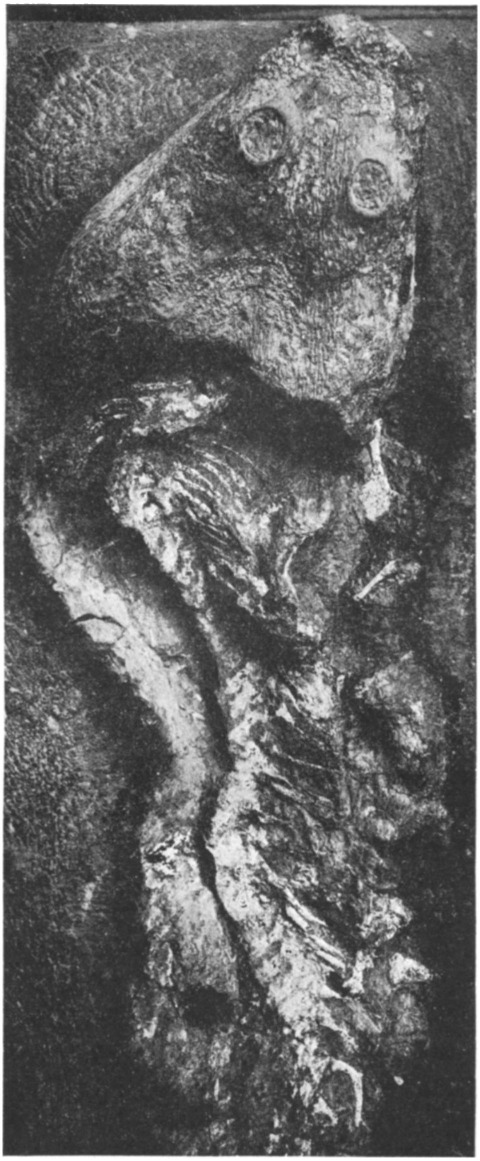

FIG. 1.—*Trimerorhachis*. Specimen No. 1271, in original matrix. About one-fourth natural size.

The cadaver had come to rest in a prone position, apparently, with the head and tail directed obliquely upward, its vertebrae connected throughout in a sinuous curve, and the ribs nearly all in immediate connection with their articulating diapophyses. The right humerus had been dislocated, and lay near the posterior end of the right mandible, with its radius a little distance from its distal end. The right femur lay nearly in apposition with the acetabular part of the ilium; its distal part had been eroded away. Doubtless both the front and the hind legs of the left side are buried somewhere in the matrix.

The remarkable and wholly unexpected fact disclosed by these specimens is the presence of a thin bony skin or armor closely sheathing the whole body, with the exception of the skull and clavicular girdle. As the cadaver came to rest it was immersed in the soft mud to near its middle. The skin lining the cavity thus made retains its original position. On the decay of the body, the bones fell to the lower part, closely covered everywhere by the skin of the upper part of the body. On the right side the skin had bulged outward near the middle. When first uncovered the bones were concealed everywhere by the skin. It has been removed on one side or the other to expose the bones, and between them, in a few places, to show the skin of the under side of the body, which in some places lies in juxtaposition with that of the upper side, in others separated by a thin layer of the matrix.

A dermal covering of peculiar type in *Trimerorhachis* has been several times observed by Cope, Case, and myself, but it was assumed that it covered the ventral region only, and its nature was ill understood. The present specimens show very conspicuously that it covered the whole body, with the exceptions mentioned; in the preparation of the skull not a trace of it was seen, but it is closely connected with its hind margins. In no place in these specimens does it appear to have been more than a millimeter in thickness. It is composed of slender and delicate bony fibrillae, in short pieces, and apparently in several layers. In another specimen (Fig. 3, *B*, *C*,) transverse sections show that the bony rods were in numerous layers. As these fibrillae lie in this specimen they extend through a thickness of 6 or 8 mm., and are separated from each other by intervals greater than their own thickness. It seems hardly possible that postmortem causes could have separated them so uniformly, and one must conclude that they were imbedded in a considerable thickness of integument, at least a fourth of an inch. How long any of the rods were I cannot say; the longest connected piece that I trace is scarcely a fourth of an inch. It is still possible that the sections represent the ventral skin, since nothing of their character is visible in the connected skeleton.

Notwithstanding this thickness, the skin must have been flexible to have followed every inequality of the bones below it. It was doubtless covered by a smooth epidermis.

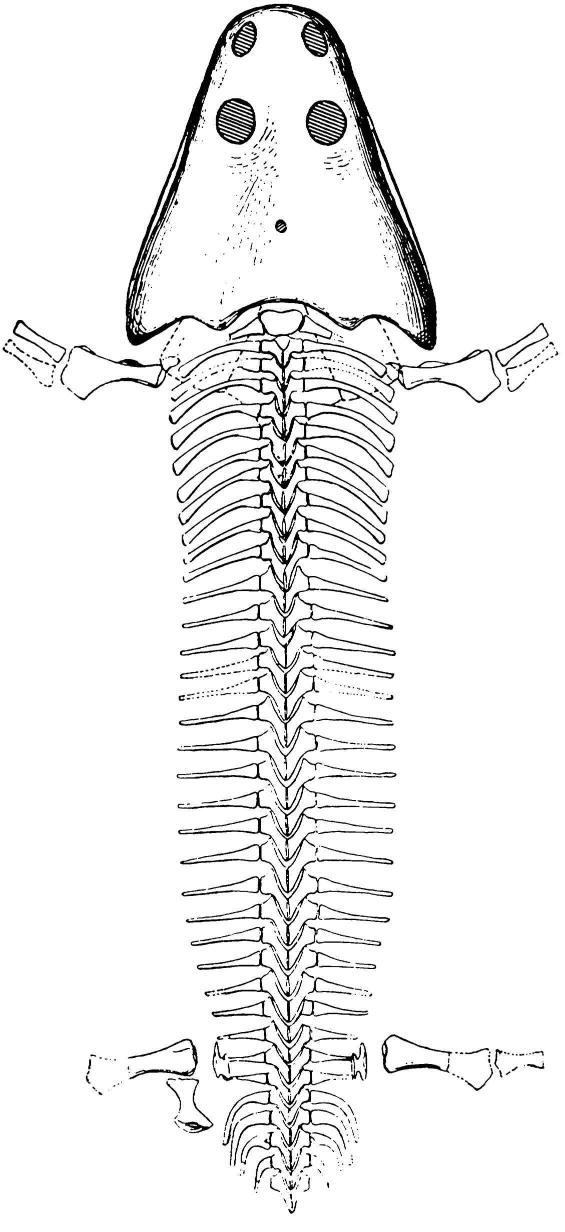

FIG. 2.—*Trimerorhachis*. Skeleton, from above, as restored from specimen shown in Fig. 1. One-fourth natural size.

Thirty-one precaudal vertebrae are visible, all in close articulation, the first one apparently with the condyle. That the vertebral column was very flexible is evident from its sinuosity as it lies in the matrix, without break. The general structure of the vertebrae is well known from isolated specimens. The pleurocentra are very small, and the intercentra are more or less U-shaped, indicating a large amount of cartilage. The spines are of nearly uniform height throughout the column, curving backward and upward, and slightly dilated at their extremities. Their height above the plane of the zygapophyses is nowhere more than 14 mm.; their width at the ends from 8 to 10 mm.

The ribs are preserved very completely in position; all have been exposed on one side or the other except two, near the middle. The first eight are the longest, measuring about 52 mm. They also have a considerable curvature and are more or less expanded at their extremities. With the tenth or eleventh they have decreased in length to 45 mm., are less curved, and not dilated at their distal ends. Thence to the tenth precaudal they are of uniform length, more slender, and pointed. When seen from above these are all slender and nearly straight, with a moderately expanded proximal end; when turned upon their sides they are broader, somewhat curved, and with a more dilated head. Apparently some of them at least have a capitular prolongation in articulation with the intercentra. The first two precaudal ribs are slender, pointed, and entirely free, and about one inch in length.

The right humerus lies near the angle of the right mandible, as will be seen in the photograph, with its head directed forward, and with the radius somewhat removed from its distal end. There are no remains of the skin either above or below these bones. Some half-dozen skulls of *Trimerorhachis* have now been obtained with the peculiar clavicular girdle in position or nearly so, lying more or less between the mandibles posteriorly. In the drawing (Fig. 2) I have outlined in interrupted lines a clavicular girdle of another skull of the same size as the present one, in position, placing it farthest back of any of the connected specimens. The angles of the clavicles with their ascending process must indicate the position of the scapula and articulation of the humerus. The scapula is hidden and not certainly determinable in this specimen, though the edge of a protruding bone at the inner side of the distal end of the humerus, as it lies in the matrix, is probably that of the scapula. The scapula, ilium, and limbs of the left side are doubtless preserved in this specimen covered by the skin and matrix, but it has not been thought wise to sacrifice so much of the specimen as might be necessary in the search for them. In all the material from the bone-beds so far examined not a trace has been found of hand or foot bones, so that nothing can be said of their structure.

The right ilium lies in place in the matrix, in a vertical position opposite the ends of the first two presacral ribs. The bone is relatively very small, as will be seen from the figure. Among the numerous ilia in the collections (I have seen about two score) there is no indication of roughening for attachment to sacral ribs. So far as was prudent the matrix has been removed about the ilium; there are no indications of ossified pubis or ischium. The proximal end of the right femur lies nearly in place opposite the acetabular surface of the ilium, directed outward; its distal end has been lost from erosion of the matrix.

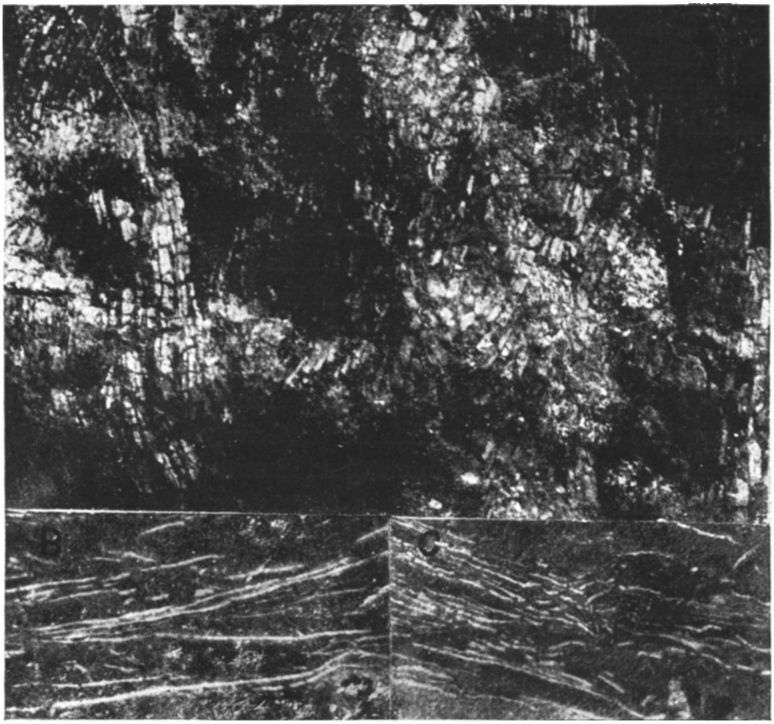

FIG. 3—*Trimerorhachis* Integument. *A*, surface view, No. 1271. *B*, *C*, cross-sections. No. 1208. All enlarged four times.

The looseness and small size of the ilium and the probable chondrification of the other pelvic bones are conclusive evidence, if more were needed, that *Trimerorhachis* was an exclusively aquatic animal, incapable of progression upon land. Are the undifferentiated "sacral" ribs and their lack of connection with the ilia a primitive or an acquired character? In such animals as the mosasaurs and ichthyosaurs, when the connection of the pelvis with the sacrum was lost, the ribs disappeared; they did not revert to their primitive forms. On the other hand, *Necturus* has its sacral ribs differing from the preceding ones only in their slightly larger size, and *Necturus* certainly has not had an exclusively aquatic ancestral line from the fishes. *Necturus* also has its lower pelvic bones, as well as the mesopodials, cartilaginous, and their ancestors at some time must have had them ossified.

Not only was *Trimerorhachis* a purely aquatic animal, but, in much probability, it was also, like *Necturus*, perennibranchiate. Lying just within the angle of the left mandible there is the end of a flat bone, 11 mm. in width, with a more slender anterior end directed forward and inward, that can only be an unusually large hyoid or epibranchial bone. Back of it there is the end of what appears to be a smaller one. On either side of the first vertebrae, directed forward and outward, there are the ends of three small, rib-like bones; I do not know what they are. The length of the skull in this specimen (No. 1,271) is 165 mm.; its width posteriorly the same. The length to the beginning of the tail, allowing for the sinuosities, is 550 mm. The length of the entire animal—and the specimen is one of the largest—must have been less than one meter.